Journal of Cell and Tissue Research Vol. 20(2): 6897-6913 (2020)
(Available online at www.tcrjournals.com)
ISSN: 0973-0028; E-ISSN: 0974-0910

Review Article

WHAT YOUR BLOOD TELLS? A REVIEW

GUPTA, P. D.

Former, Director grade Scientist, Centre for Cellular and Molecular Biology,
Hyderabad, India. E. mail: pdg2000@hotmail.com, Cell: 91 80-728 91356

Received: August 15, 2020; Accepted: September 5, 2020

Abstract: In the human body blood is the only liquid organ made up of various types of cells suspended in the plasma; the plasma makes it easy to flow in arteries and veins through heart. Red blood cells (RBCs) gives it red colour due to the presence of hemoglobin which helps in exchange of gases. White blood cells constitute the part of immune system which fights infections. The blood can be transfused from one person to another provided care is taken to match antigens present (A, B or O) on the RBCs. Blood cells are produced in bone marrow which under certain diseased conditions can be transplanted. Blood as an organ also suffers with many ailments including cancer. Latest researches show that cord blood and menstrual blood contain valuable materials which can be used for the treatment of various diseases if immune system.

Key words: Human blood

INTRODUCTION

Blood is made up of blood cells and plasma; the liquid part, called plasma, is made of water, salts, and protein. Over half of the blood is plasma, which is made up of a yellowish fluid that has water, amino acids, carbohydrates, lipids, hormones, vitamins, electrolytes, dissolved gasses, and cellular wastes. The solid part is made up of, red blood cells, platelets, and a mixture of different types of white blood cells. The cellular material (99% red blood cells, with white blood cells and platelets making up the remainder), The different types of blood cells have different jobs. Blood is like the body's superhighway; it is the life-giving fluid that delivers oxygen and nutrients to all parts of the body. Blood circulating in the body is composed of about 55 % plasma, 40% red blood cells, 4 % platelets, and 1 % white blood cells. The blood accounts for about 7 to 8% of the body weight. Of the white blood cells in blood circulation, neutrophils are the most abundant [1]. An average adult body with a weight of 150 to 180 pounds will contain approximately 4.7 to 5.5 litters (1.2 to 1.5 gallons) of blood. The average adult weighing 150 to 180 pounds should have about 1.2 to 1.5 gallons of blood in their body. This is about 4,500 to 5,700 mL. To support their growing babies, pregnant women usually have anywhere from 30 to 50 percent more blood volume than women who are not pregnant. Blood also fights infections, and carries hormones around the body.

Colour of the blood: The respiratory pigment is responsible for the colour of blood. The blood is not always red, of course, humans always have red coloured blood and the parasites on human who sucks human blood such as lice, mosquito, etc. will also have red blood but many others have blood of varying colours. Lobsters, prawns, spiders, squids, and octopuses have blue blood. Some types of worms and leeches have green blood. Some species of marine worms have violet blood. Insects, including beetles and butterflies, have colourless or pale-yellowish blood. The four most common respiratory pigments are hemoglobin, hemocyanin, hemerythrin

and chlorocruorin. Hemoglobin is bright red when oxygenated, and dark red (purplish) when deoxygenated, oxygenated hemocyanin is blue in colour, deoxygenated it is almost colourless. Oxygenated chlorocruorin turns from green to red, whereas oxygenated hemerythrin is a violet to pink colour and colourless when deoxygenated. Any of various coloured conjugated proteins, such as hemoglobin, occur in living organisms and function in oxygen transfer in cellular respiration.

The plasma volume: Blood circulating in the body is composed of about 55 percent plasma, 40 percent red blood cells, 4 percent platelets, and 1 percent white blood cells. Of the white blood cells in blood circulation, neutrophils are the most abundant. The adult human body contains approximately 1.325 gallons of blood. Blood makes up about 7 to 8 percent of a person's total body weight.

Importance of blood components: A certain proportions of all the components have to be maintained in the healthy body. Plasma gives fluidity for easy flow in the blood vessels (arteries and veins) whereas red blood cells carry oxygen. The white blood cells are important for a healthy immune system that gives protection from infection. What is less known is that certain white blood cells called macrophages are necessary for pregnancy to occur? Macrophages are prevalent in reproductive system tissues. Macrophages assist in the development of blood vessel networks in the ovary, which is vital for the production of the hormone pro-gesterone. Progesterone plays a critical part in the implantation of an embryo in the uterus. Low macrophage numbers result in reduced progesterone levels and inadequate embryo implantation [1].

Metals in the blood: Human blood contains metals atoms including iron, chromium, manganese, zinc, lead, and copper. You may also be surprised to know that blood contains small amounts of gold. The human body has about 0.2 milligrams of gold that is mostly found in the blood [2].

Functions of the blood: Blood is a component of the cardiovascular system. Blood is a connective tissue because it is a collection of similar specialized cells that serve particular functions. These cells are suspended in a liquid matrix (plasma), which makes the blood a fluid organ. It is circulated through the body via pumped by the heart and circulating in blood vessels; a type of a transport liquid by the heart to all parts of the body, after which it is returned to the heart to repeat the process. Blood plays an important role in regulating the body's systems and maintaining homeostasis. While circulating in the body, it is transporting substances to and from our cells and providing oxygen and nutrients to tissues, removing waste, transporting hormones and other signals throughout the body, immunity and protection against infectious agents such as bacteria and viruses. In addition to these vital functions blood also regulates body pH and core body temperature.

We breathe oxygen which is brought into the lungs; Blood absorbs oxygen from air in the lungs. Oxygen is transported by red blood cells to the entire body to be used to produce energy. Oxygen is needed to burn the fuel (sugars and fatty acids) in our cells to produce energy.

The blood is composed of 90% water, salts, lipids and hormones; it is especially rich in proteins (including its main protein albumin), immunoglobulins, clotting factors and fibrinogen carrying cells and antibodies that fight infection. Albumin is the main protein found in plasma, and it functions to regulate the colloidal osmotic pressure of blood.

If clotting mechanisms are stimulated in the blood, platelet aggregation and interactions with plasma proteins occur. This leads to entrapment of red cells and clot formation, which dramatically increases blood viscosity.

Genesis of the Blood:

Bone marrow and blood cell development: Bone marrow is the soft, flexible connective tissue within bone cavities (Fig. 1). A component of the lymphatic system, bone marrow functions primarily to produce blood cells and to store fat. Bone marrow is highly vascular, meaning that it is richly supplied with a large number of blood vessels. There are two categories of bone marrow tissue: red marrow and yellow marrow. From birth to early adolescence, the majority of our bone marrow is red marrow. As we grow and mature, increasing amounts of red marrow is replaced by yellow marrow. On average, bone marrow can generate hundreds of billions of new blood cells every day. Here, the periosteum (outer bone membrane, pink), compact bone (yellow) and bone marrow (red), in the medullary cavity, can be seen. .

Bone marrow structure: Bone marrow is the spongy tissue inside some of the bones, such as hip and thigh bones. It contains stem cells. The stem cells can develop into the red blood cells that carry oxygen through your body, the white blood cells that fight infections, and the platelets that help with blood clotting. Bone marrow is separated into a vascular section and non-vascular sections. The vascular section contains blood vessels that supply the bone with nutrients and transport blood stem cells and mature blood cells away from the bone and into circulation. The non-vascular sections of the bone marrow are where hematopoiesis or blood cell formation occurs. This area contains immature blood cells, fat cells, white blood cells (macrophages and plasma cells), and thin, branching fibbers of reticular connective tissue. While all blood cells are derived from bone marrow, some white blood cells mature in other organs such as the spleen, lymph nodes, and thymus gland.

Bone marrow function: The major function of bone marrow is to generate blood cells. Bone marrow contains two main types of stem cells. Hematopoietic stem cells, found in red marrow, are responsible for the production of blood cells. Bone marrow mesenchymal stem cells (multi-potent stromal cells) produce the non-blood cell components of marrow, including fat, cartilage, fibrous connective tissue (found in tendons and ligaments), stromal cells that support blood formation, and bone cells [4].

Red Marrow: In adults, red marrow is confined mostly to skeletal system bones of the skull, pelvis, spine, ribs, sternum, shoulder blades, and near the point of attachment of the long bones of the arms and legs. Not only does red marrow produce blood cells, but it also helps to remove old cells from circulation. Other organs, such as the spleen and liver, also filter aged and damaged blood cells from the blood. Red marrow contains hematopoietic stem cells that produce two other types of stem cells: myeloid stem cells and lymphoid stem cells. These cells develop into red blood cells, white blood cells, or platelets.

Yellow marrow Yellow marrow consists primarily of fat cells. It has poor vascular supply and is composed of hematopoietic tissue that has become inactive. Yellow marrow is found in spongy bones and in the shaft of long bones. When blood supply is extremely low, yellow marrow can be converted to red marrow in order to produce more blood cells [4].

Bone marrow stem cells

- **Myeloid stem cells:** develop into red blood cells, platelets, mast cells, or myeloblast cells. Myeloblast cells develop into granulocyte and monocyte white blood cells.
- **Red blood cells:** also called erythrocytes, these cells transport oxygen to body cells and deliver carbon dioxide to the lungs.
- **Platelets:** also called thrombocytes, these cells develop from megakaryocytes (huge cells) that break into fragments to form platelets. They aid in the blood clotting process and tissue healing.
- **Myeloblast granulocytes (white blood cells) :** develop from myeloblast cells and include neutrophils, eosinophils, and basophils. These immune cells defend the body against foreign invaders (bacteria, viruses, and other pathogens) and become active during allergic reactions.
- **Monocytes:** these large white blood cells migrate from blood to tissues and develop into macrophages and dendritic cells. Macrophages remove foreign substances, dead or damaged cells, and cancer cells from the body by phagocytosis. Dendritic cells aid in the development of antigen immunity by presenting antigenic information to lymphocytes. They initiate primary immune responses and are commonly found in the skin, respiratory tract, and gastrointestinal tract.
- **Mast cells:** these white blood cell granulocytes develop independently from myeloblast cells. They are found throughout body tissues, particularly in the skin and lining of the digestive system. Mast cells mediate immune responses by releasing chemicals, such as histamine, stored in granules. They aid in wound healing, blood vessel generation, and are associated with allergic diseases (asthma, eczema, hay fever, etc.)
- **Lymphoid stem cells:** develop into lymphoblast cells, which produce other types of white blood cells called lymphocytes. Lymphocytes include natural killer cells, B lymphocytes, and T lymphocytes.
- **Natural killer cells:** these cytotoxic cells contain enzymes that cause apoptosis (cellular self-destruction) in infected and diseased cells.
- They are components in the body's innate immune response protecting against pathogens

Fig. 1: Scanning electron micrograph (SEM) is showing the internal structure of a broken finger bone.

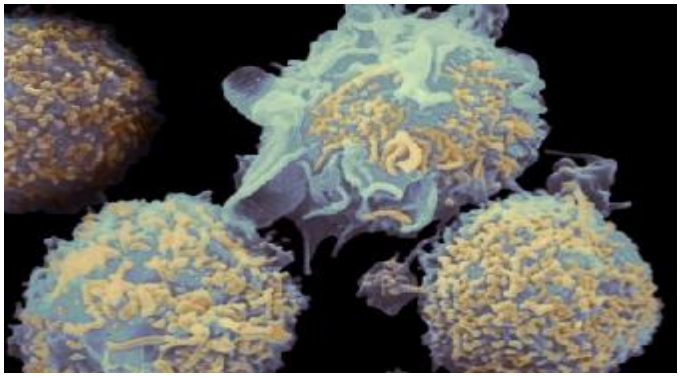

Fig. 2: SEM of abnormal white blood cells (B-lymphocytes) from a patient suffering from hairy cell leukemia. Prof. Aaron Polliack/Science Photo Library

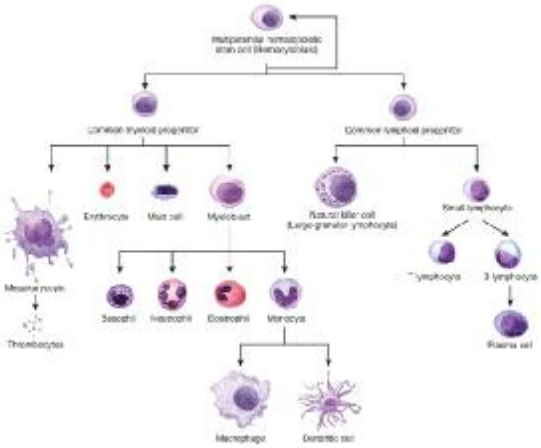

Fig. 3a: SEM showing Blood cells

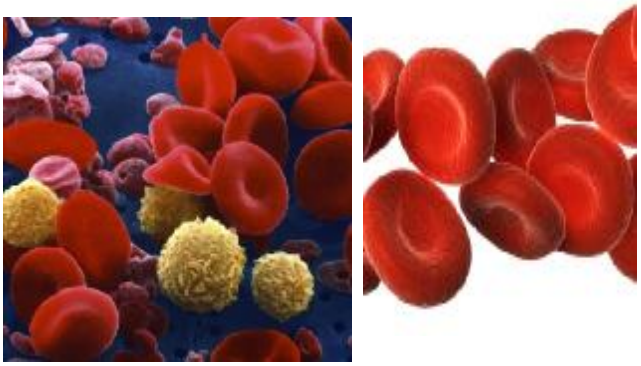

Fig. 3b: SEM showing isolated RBCs

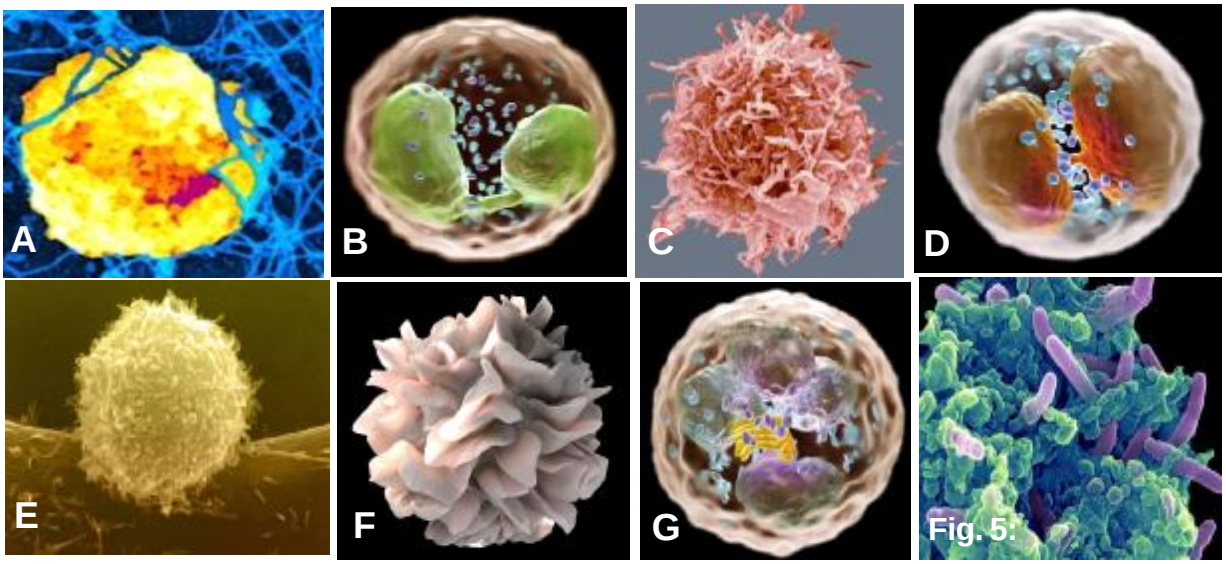

Fig. 4 A. T cell, **B.** Dendritic cell, C. Neutrophil. **Rest (D,E,F.G)** are platelets (thrombocytes): These cell components are formed from pieces of cells found in bone marrow called megakaryocytes. Fragments of the megakaryocytes circulate through the blood stream and play a major role in clotting. When platelets encounter an injured blood vessel, they clump together to block the opening in the vessel.

Fig.5: Scanning electron micrograph (SEM) of Mycobacterium tuberculosis (purple) infecting a macrophage which when activated engulf the bacteria and destroy

and tumor development.

- **B cell lymphocytes:** these cells are important for adaptive immunity and long lasting protection against pathogens. They recognize molecular signals from pathogens and produce antibodies against specific antigens.
- **T cell lymphocytes:** these cells are active in cell mediated immunity. They help to identify and destroy damaged, cancerous, and infected cells.

Bone marrow disease: In bone marrow disease, the body's bone marrow is not able to produce enough healthy blood cells. Bone marrow disease may develop from marrow and blood cancers, such as leukemia.

Hairy cell leukemia: Leukemia is a blood cancer in which the blood-producing tissue in bone marrow produces excessive numbers of immature white blood cells, which impair the function of normal blood cells (Fig. 2). The immune system is thus weakened. Cells show characteristic hair-like cytoplasmic projections and ruffles on their surfaces.

Bone marrow that becomes damaged or diseased results in low blood cell production. Radiation exposure, certain kind of infections, and diseases including aplastic anemia and myelofibrosis can also cause blood and marrow disorders. These diseases compromise the immune system and deprive organs and tissues of the life giving oxygen and nutrients they need. A bone marrow transplant may be performed in order to treat blood and marrow diseases. In the process, damaged blood stem cells are replaced by healthy cells obtained form a donor. The healthy stem cells can be obtained from the donor's blood or bone marrow. Bone marrow is extracted from bones located in places such as the hip or sternum. Stem cells may also be obtained from umbilical cord blood to be used for transplantation.

Blood cells are renewable: In humans, all blood cells originate from hematopoietic stem cells. About 95 percent of the body's blood cells are produced in the bone marrow. In an adult, most of the bone marrow is concentrated in the breastbone and in the bones of the spine and pelvis. Several other organs help to regulate the production of blood cells. These include the liver and lymphatic system structures such as the lymph nodes, spleen, and thymus. Matured human blood cells have varying life cycles. Red blood cells circulate in the body for about 4 months, platelets for about 9 days, and white blood cells range from a few hours to several days [8].

Red blood cells have no nucleus: Unlike other types of cells in the body, mature red blood cells do not contain a nucleus, mitochondria, or ribosome. The absence of these cell structures leaves room for the hundreds of millions of haemoglobin molecules found in red blood cells [9].

Blood proteins protect against carbon monoxide poisoning: Carbon monoxide (CO) gas is colourless, odourless, tasteless and toxic. It is not only produced by fuel burning devices but is also produced as a by-product of cellular processes. If carbon monoxide is produced naturally during normal cell functions, why aren't organisms poisoned by it? Because CO is produced in much lower concentrations than seen in CO poisoning, cells are protected from its toxic effects. CO binds to proteins in the body known as hem proteins [7]. Haemoglobin found in blood and cytochromes found in mitochondria are examples of hem proteins. When CO binds to haemoglobin in red blood cells, it prevents oxygen from binding to the protein molecule leading to disruptions in vital cell processes such as cellular respiration. At low CO concentrations, hem proteins change their structure preventing CO from successfully binding to them. Without this structural change, CO would bind to the hem protein up to a million times more tightly.

Capillaries spit out blockages in blood: Capillaries in the brain can expel obstructive debris. This debris may consist of cholesterol, calcium plaque, or clots in the blood. Cells within the capillary grow around and enclose the debris. The capillary wall then opens up and the obstruction is forced out of the blood vessel into the surrounding tissue. This process slows down with age and is thought to be a factor in cognitive decline that occurs as we age. If the obstruction is not completely removed from the blood vessel, it can cause oxygen deprivation and nerve damage.

II. Blood Components

The composition of blood: Blood is slightly denser and approximately 3-4 times more viscous than water. Blood consists of cells which are suspended in a liquid. Blood volume is variable but tends to be about 8% of body weight. Factors such as body size, the amount of adipose tissue, and electrolyte concentrations all affect volume. The average adult

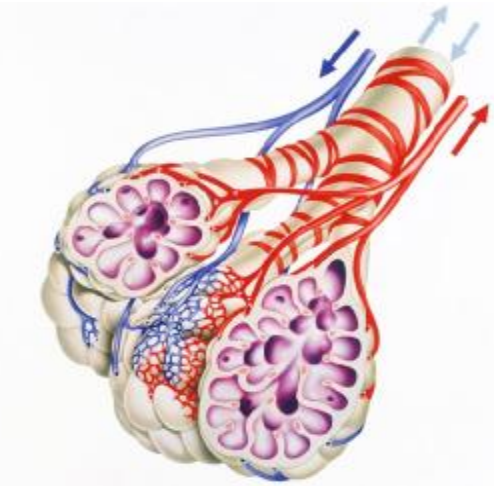

Fig. 6: The pulmonary artery carries impure blood to the right and left lungs. The left half of the heart collects and pumps pure (oxygenated) blood from the lungs to all parts of the body. The blood from the lungs enters the heart from four veins called the Pulmonary Veins.

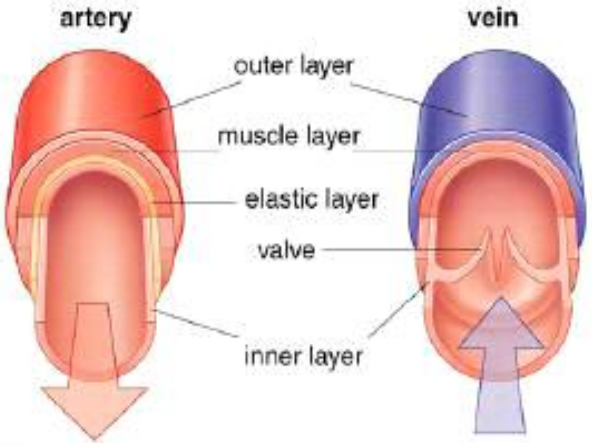

Fig.7: Artery and vein comparison

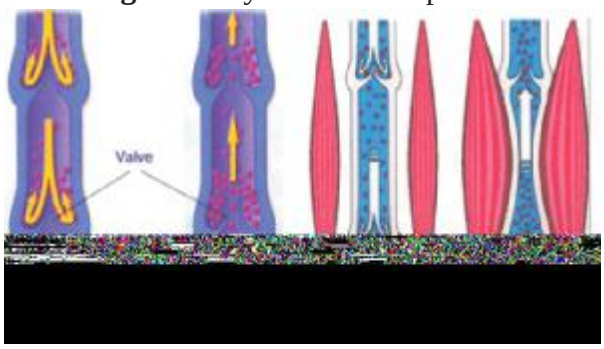

Fig. 8: Opening and closure of veins

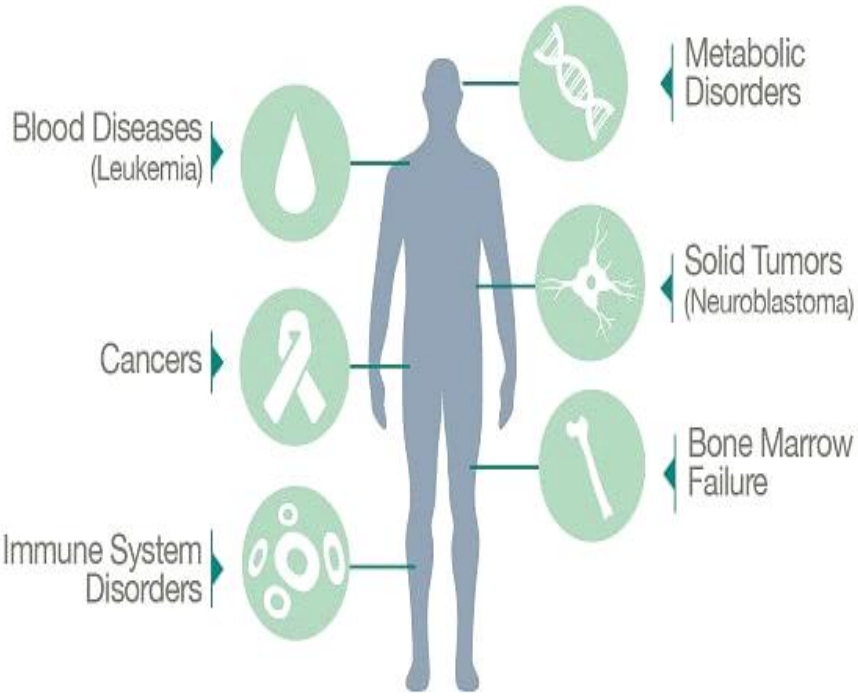

Fig 9: Cord blood is currently approved to treat nearly 80 diseases of the blood and immune system

has about 5 liters of blood. As with other suspensions, the components of blood can be separated by filtration; however, the most common method of separating blood is centrifugation. Three layers are visible in centrifuged blood. The straw-colour liquid portion, called plasma, forms at the top is about 55%. A thin cream-colored layer, called the buffy coat, forms below the plasma. The buffy coat consists of white blood cells and platelets. The red blood cells form the heavy bottom portion of the separated mixture is ~45%. Each red blood cell is about 1/3 hemoglobin, by volume. Plasma is about 92% water, with plasma proteins as the most abundant solutes. The main plasma protein groups are albumins, globulins, and fibrinogens. The primary blood gasses are oxygen, carbon dioxide, and nitrogen [5].

Importance of blood components A certain proportions of all the components have to be maintained in the healthy body. Plasma gives fluidity for easy flow in the blood vessels (arteries and veins) whereas red blood cells carry oxygen. The white blood cells are important for a healthy immune system that gives protection from infection (Fig. 3 A). What is less known is that certain white blood cells called macrophages are necessary for pregnancy to occur? Macrophages are prevalent in reproductive system tissues. Macrophages assist in the development of blood vessel networks in the ovary, which is vital for the production of the hormone progesterone. Progesterone plays a critical part in the implantation of an embryo in the uterus. Low macrophage numbers result in reduced progesterone levels and inadequate embryo implantation and preterm birth or abortions.

Erythrocytes (Red Blood Cells): These cells determine blood type and are the most abundant cell type in the blood. Red blood cells have what is known as a biconcave shape. Both sides of the cell's surface curve inward like the interior of a sphere. This flexible disc shape helps increase the surface area-to-volume ratio of these extremely small cells. Red blood cells do not have a nucleus, but they do contain millions of hemoglobin molecules (Fig. 3 B). These iron containing proteins bind oxygen molecules obtained in the lungs and transport them to various parts of the body. After depositing oxygen to tissue and organ cells, red blood cells pick up carbon dioxide (CO2) for transportation to the lungs where the CO2 is expelled from the body [5,7].

White blood cells (leukocytes): These cells play an important role in the immune system and lymphatic system by defending the body against infection. These cells locate, destroy, and remove pathogens and foreign matter from the body [6]. There are several different types of white blood cells, each with different functions. Examples include lymphocytes, monocytes, neutrophils, basophils, and eosinophils (Figs. 4 A to G).

Monocytes are the largest of the white blood cells. Macrophages are monocytes that are present in nearly all tissue. They digest cells and pathogens by engulfing them in a process called phagocytosis. Once ingested, lysosomes within the macrophages release hydrolytic enzymes which destroy the pathogen. Macrophages also release chemicals that attract other white blood cells to areas of infection. Macrophages aid in adaptive immunity by presenting information about foreign antigens to immune cells called lymphocytes. Lymphocytes use this information to quickly mount a defense against these intruders should they infect the body in the future (Fig. 5). Macrophages also perform a number of functions outside of immunity. They assist in sex cell development, steroid hormone production, resorption of bone tissue, and blood vessel network developpment.

III. Blood Types

The human ABO blood groups were discovered by Austrian-born American biologist Karl Landsteiner in 1901. ABO blood group system, the classification of human blood based on the inherited properties of red blood cells (erythrocytes) as determined by the presence or absence of the antigens A and B, which are carried on the surface of the red cells. Each biological parent donates one of their two ABO alleles to their child. A mother who is blood type O can only pass an O allele to her son or daughter. A father who is blood type AB could pass either an A or a B allele to his son or daughter. Persons may thus have type A, type B, type O, or type AB blood. Human blood is grouped on the basis of antigen present on red blood cells into four types: A, B, AB, and O. Each letter refers to a kind of antigen, or protein, on the surface of red blood cells. For example, the surface of red blood cells in Type A blood has antigens known as A-antigens. Almost always, an individual has the same blood group for life, but very rarely an individual's blood type changes through addition or suppression of an antigen in infection,

malignancy, or autoimmune disease. Another more common cause of blood type change is a bone marrow transplant [10].

Rhesus (Rh) factor is an inherited protein found on the surface of red blood cells. If blood has the protein, you're Rh positive. If your blood lacks the protein, you're Rh negative. Rh positive is the most common blood type. Everyone has an ABO blood type (A, B, AB, or O) and an Rh factor (positive or negative). Just like eye or hair colour, our blood type is inherited from our parents. Each biological parent donates one of two ABO genes to their child. The A and B genes are dominant and the O gene is recessive.

If the blood is A positive (A+), it means that the blood contains type-A antigens with the presence of a protein called the rhesus (Rh) factor. Antigens are markers on the surface of a blood cell. According to the American Red Cross, this is one of the most common blood types. Because so few people have it, by definition, rare blood is hardly ever needed.The most important of these Rh antigens, the D antigen, is quite often missing in Caucasians, of whom around 15 percent are Rh D-negative (more commonly, though inaccurately, known as Rh-negative blood). Blood type distributions vary by population for example, AB-negative (6 percent), B-negative (1.5 percent) AB-positive (3.4 percent), A-negative (6.3 percent), O-negative (6.6 percent) B-positive (8.5 percent), A-positive (35.7 percent), O-positive (37.4 percent). Compared to participants with type O blood, those with type A had a 32 percent higher chance of incurring pancreatic cancer, those with type AB had a 51 percent higher chance, and those with type B had a 72 percent higher chance.

A new study suggests that the risk for stroke is tied to blood type, with men and women with type AB and women with type B facing greater risk than people with type O. A mother and child may also have an ABO blood type incompatibility, which can also cause hemolytic disease of the newborn. However, this incompatibility usually has less serious consequences. It occurs when the mother is type O and the baby is A, B, or AB. According to T Mary Cushman of the University of Vermont College of Medicine in Burlington, the blood type AB is only found in about 4% of the US population, yet people with this blood type were 82% more likely than other types to develop the thinking and memory problems that can lead to dementia his new study supports 2014 Harvard Medical Study that found that people with type 'AB' blood were 82% more likely to have cognitive impairment than those with 'O' blood type. People whose blood type is A, B or AB have an increased risk of heart disease and shorter life spans than people who have type O blood, according to a new study. It is revealed that women with blood type A were 10% more likely to develop type 2 diabetes than women with blood type O, while women with blood type B were 21% more likely to develop the condition.

Researchers found that people with type O blood also have higher risk of heart attack or unstable chest pain in times of high air pollution. But their level of risk is much smaller, at 10 percent instead of the non-O blood type's 25 percent per 10 additional micro-grams per cubic meter. The most common blood type in the United States is O positive. The least common is AB negative. The most common blood type in Japan is A positive.

The test to determine blood group is called ABO typing. Your blood sample is mixed with antibodies against type A and B blood. Then, the sample is checked to see whether or not the blood cells stick together. If blood cells stick together, it means the blood reacted with one of the antibodies.

What blood type says about you?

Ketsueki-Gata Personalities Associated With Blood Types*

Blood Type	**PROS**	
Blood Type	A	Stubborn and tense
Blood Type	B	Selfish, irresponsible, unforgiving, and erratic
Blood Type	AB	Critical, indecisive, forgetful, and irresponsible
Blood Type	O	Self-centered, cold, unpredictable, and a potential workaholic

They're A, B, AB, and O. A tiny bit of protein, called an antigen, on the surface of a red blood cell determines what type you have. If you have the A antigen, you have blood type A; the B antigen gives you blood type B. If you have both A and B, you have blood type AB. If you have no antigens, you have blood type O. If you have this on your red blood cells, you have a positive blood type. If you don't, you have a negative blood type. For example, if you have the A antigen and the Rh factor, your blood

type is A positive. If you have the B antigen but no Rh factor, your blood type is B negative. A simple blood test can tell you which type you have.

Type O is the most common type. 43% of Americans have it. On the flip side, if you have AB blood, you're at higher risk compared to people with other blood types. That's also the rarest type — less than 10% of people in the U.S. have it. They're 82% more likely to have the issues that can lead to dementia than people with other types. People with type O have the lowest risk of developing the condition.

Ideally, you should get your own blood type if you need a transfusion (when blood from one person is given to another). But in an emergency, O negative can be used by anyone with any blood type. That's because it doesn't have any of the antigens - A, B, or Rh - that can lead your immune system to attack it. About 7% of people in the U.S. have O negative blood. They're known as "universal recipients" because their blood has all the antigens — A, B, and Rh. If you have this type, your body will recognize any other blood type as its own.

A woman's blood can attack her baby's blood cells if she's Rh negative and the baby is Rh positive. This is called rhesus disease, and medication can prevent it. If you're pregnant, you should have a blood test to find out your Rh factor. If you're Rh negative, your doctor will recommend that you take the medication to be safe.

Removing blood cell antigens: Scientists have discovered enzymes that can efficiently remove blood cell antigens and can make blood suitable for transfusion to everyone whether one has A, B, AB or O group. The two novel glycosidase enzymes were identified in bacteria which removes blood antigens. Clinical trials to test the safety and effectiveness of their converted blood are being planned [11].

The ABO blood-type system is based on the presence or absence of the sugar-based antigens 'A' and 'B' on red blood cells. Type O blood cells have neither A nor B antigens, so may be safely transfused into anyone. But types A, B and AB blood do, and cause life-threatening immune reactions if they are given to patients with a different blood group. The bacterial glycosidase enzymes strip these antigens away from A, B and AB blood.

The idea of such antigen-stripping goes back to the early 1980s, with the discovery of an enzyme in coffee beans that removes B antigens from red blood cells [12]. Early-stage clinical trials showed that the converted blood could be safely transfused into individuals of different blood groups; no traces of enzyme or antigen remained to cause reactions [2]. But the enzyme reaction was far too inefficient to make large-scale conversion practical.

Blood transfusion: The blood carries oxygen and nutrients to all parts of your body. Blood transfusions replace blood that is lost through surgery or injury or provide it if your body is not making blood properly. You may need a blood transfusion if you have anemia, sickle cell disease, a bleeding disorder such as hemophilia, or cancer. For people in critical condition, blood transfusions can be life saving. To minimize the chance of an adverse reaction during a transfusion, before starting the transfusion several precautions should be taken [13].

Four types of blood products may be given through blood transfusions. whole blood, red blood cells platelets, and plasma. Most of the blood used for transfusions comes from whole blood donations given by volunteer blood donors.

Technique of transfusion: Allergic reactions, infections, fever, and iron overload risks and complications are the risks in blood transfusion. Most blood transfusions go very smoothly. However, mild problem and, very rarely, serious problems can occur. To minimize the chance of an adverse reaction during a transfusion certain care/precausions should be taken. Before starting the transfusion, the person is cross-matched with the donor blood. The benefits of a transfusion may last for up to 2 weeks but vary, depending on circumstances. There are various types of transfusion that may provide an individual with specific elements of blood, such as plasma or red blood cells.

In 1818 Dr. James Blundell made efforts to treat hemorrhage by transfusion of human blood using a syringe. Use of an 18-gauge (or larger) needle prevents mechanical damage to and hemolysis of RBCs. A standard filter should always be used for infusion of any blood component. Only 0.9% saline IV should be allowed into the blood bag.

Transfusion of 1 unit of blood or blood component

should be completed by 4 h; longer duration increases the risk of bacterial growth. If transfusion must be given slowly because of heart failure or hypervolemia, Close observation is important, particularly during the first 15 min, and includes recording temperature, blood pressure, pulse and respiratory rate.

Effects of donating blood : Blood donation is safe for healthy adults. There's no risk of contracting disease. It turns out that donating blood doesn't just benefit recipients. There are health benefits for donors too, Donating blood has benefits for the emotional and physical health. According to a report by the Mental Health Foundation, helping others can reduce stress, improve emotional well-being, benefit physical health, help get rid of negative feelings, provide a sense of belonging and reduce isolation

Depending on the gender, height, weight, and total blood volume, one can give up to 2 pints in an automated blood collection. For example, one donor may be able to donate two units of red blood cells; another may donate one unit of platelets and one unit of Plasma.

IV. Diet according to blood type: Recently researchers found a relationship between antigen present on the RBC and the preference of food for a person. The diet according to Blood Type is based on how our blood cells react with "lectins", the proteins found abundant in raw legumes and grains in foods. Lectins are believed to have a direct effect on the blood and the digestive tract. These proteins bind to cells within the body, causing them to clump together and potentially cause hormonal disruptions. This disruption has a similar effect on the body as a foreign substance might.

Different blood types are believed to have different reactions to certain foods. In addition to this, the blood transfusions blood type (A, B, AB, or O,), are also used for diet suggestions. Research has shown that certain blood types are at risk of developing specific diseases, for example Covid-19 prefers more people with blood group A to infect and likely to form more severe symptoms than those who are with blood type O might be resistant to it.

Diet is a nutritional regime that fits the lifestyle we have chosen for ourselves. Dieting does not necessarily have to shed calories from our bodies, and some people choose a diet to sharpen their mental fitness or their overall wellbeing, but is there a diet that suits us according to our blood type?

The blood type of a person can tell many things about the personality, and it can also provide insight into the benefits that certain foods are needed by the body. Dr. Peter D'adamo, an expert on the blood type diets and author of "Eat Right For Your Type", claims that your blood type can reveal a lot about your character and which foods best suit it.

Blood type A: With type A blood are people who look for structure, rhythm and harmony in their lives, striving to achieve peace of mind and thriving. They surround themselves with positive people who help them and support them. However, sometimes these people tend to be over-stressed, which can create hormonal imbalances in their bodies.

The recommended diet: A vegetarian diet will work best for these people; they are not having health problems such as diabetes, coronary heart disease and cancer. They switch to proteins that come from soy or eggs may seem boring, but these foods are exactly what your immune system needs in cases of hormonal imbalance. They like to incorporate more fruits, vegetables, beans, lentils, different grains and but certain types of dairy may be acceptable, including: yogurt, kefir, cheeses, including mozzarella, feta, goat cheese, ricotta, and string, cheese and goat milk into the diet.

Blood type B: The main characteristics of people with type B blood are independent and flexible, and it is easier for them to thrive in a constantly changing environment. Usually, they are relaxed people who are not stubborn, at least no more than their friends or family, and they have an open mind that can see the positive and negative side of everything. People with type B blood have higher levels of cortisol when they are stressed, but as long as they maintain their health, they significantly reduce their risk of disease and tend to be stronger physically and mentally at advanced ages than people with other blood types.

The recommended diet: Usually people with type B blood are not problematic with food, but in order to improve metabolism as much as possible and prevent fatigue or storage of liquids, it is recommended to reduce the consumption of foods such as corn, peanuts, lentils, and buckwheat. To maintain normal blood sugar levels, especially after a meal, people

with type B blood should add more green vegetables, eggs, and low-fat dairy products to their food. With regard to meat, poultry may be problematic for them. Although it is considered lean meat, it contains sticky proteins called lectin, which may create blood flow problems and lead to stroke or heart disease. Instead of chicken, you can consume proteins from plant sources, or from lamb

Blood type O: Blood type O is the only one with two antibodies, one against antigen A and one against type B antigen, and those with this type of blood are considered universal blood donors. Of all blood types, the bodies of blood type O have the best ability to digest all types of protein, fat, and calcium, because it tends to have more digestive enzymes that help absorb food. However, the negative side is that people with type O blood tend to be more susceptible to certain diseases, such as thyroid-related problems and infections, and they are also more susceptible to gastric problems.

The recommended diet: People with type O blood tend to be more impulsive and slightly fickle, so they can experience extreme mood swings. Dr. D'adamo suggests maintaining a balance in the body's chemicals with a diet that contains many proteins from lean meats, fish, vegetables and fruits, and also recommends consuming less wheat and beans and avoiding caffeine and alcohol, which can increase the level of adrenaline that is already high in people with this blood type.

Blood type AB: This is the rarest type of blood found in less than 5% of the world's population. In fact, until a few hundred years ago there were no people with this blood type. Blood type AB arises from a state in which a mixture of blood types is created that is not related to evolution or environmental factors. Therefore, people with AB blood type have characteristics that fit both blood type A and B. Usually, people with type AB feel mixed feelings about many things, are open and trust in other people, but at the same time may often feel isolated or distant from their friends. In general, people with AB blood type are very intuitive, sentimental, passionate and empathetic.

The recommended diet: People with blood type AB have lower levels of stomach acid, so it is harder for their bodies to digest proteins and tend to store more fats. Dr. D'adamo suggests that people with AB blood type should avoid caffeine and alcohol and, which will only increase the levels of stress they are likely to experience, and they should include green vegetables, tofu, and dairy products, and avoid smoked or canned meat that is difficult to digest for those with low amounts of gastric acids. Additionally, people with this blood type should divide their meals throughout the day and eat smaller portions in each meal, as well as avoid eating starches and proteins in the same meal so that their bodies can digest the food best [14].

V. Blood circulatory system: The human circulatory system consists of blood vessels, the heart and blood. The pumping of blood by heart through blood vessels helps to performs essentials tasks like transporting oxygen and nutrients to the body tissues. Further, the chemical waste produced from the body cells enters the blood, which needs to filtered and eliminated from body largely by kidney and liver. The network blood vessels is so vast and complex that it can nearly cover nearly 1,00,000 kilometres i.e. more than twice around the earth if plumbed in a single straight line. The blood vessel can be divided broadly into two major categories, arteries and veins. The arteries transmit oxygenated blood from the heart throughout the body and the veins provide a passage for deoxygenated blood to return to the heart so that it can be again enriched with the oxygen. The heart pumps the blood through blood vessels and the pumping of heart has two actions, contraction and relaxation.

The circulatory system in the body extends from the toes to the scalp. So, the blood has to complete the uphill (above the heart level) and downhill (below heart level) flow circuit continuously during walking, sitting or exercising as body will be in upright position, vertical to the earth. Then body should automatically counter act the pull of gravity [15]. This part of the operation is in opposition to the force of gravity, which exerts a downward pull on the blood stream. The blood flows directly from heart to brain in a vertically upward motion. The heart must work against gravity to pump blood up to brain, which is the body's largest consumer of oxygen. Although it is only 3% of the body's total weight, the brain consumes nearly 25% of the body's oxygen intake. Due to gravity, the circulatory system consumes much more energy to transport the blood to upper part of body (above heart level). It is also difficult to let blood return from lower limb to heart.

When the heart pumps, the blood gushes with enormous amount of force into aorta; this force diminishes as the blood stream flows through arterioles and still smaller capillaries. Most of this part of the flow circuit is downhill and gravity tends to help the circulation on its way. Further, the fine network from capillaries becomes larger (venules) which combine into still larger vessels (veins). So the body must provide extra assistance (Fig. 6).

The arteries surge more for each heartbeat and it must be able to stretch with each forceful pulse. For this reason, the walls of the main arteries are lined with strong, stretchable muscle layer which is absent in vein, as it doesn't require more amount of elasticity. But veins must be strong enough to enclose the blood stream. The walls of the veins are thinner as it has only outer, inner and muscle layer when compared with artery which has an extra elastic layer to provide more elasticity (Fig. 6). The pulmonary artery arries impure blood to the right and left lungs. The left half of the heart collects and pumps pure (oxygenated) blood from the lungs to all parts of the body. The blood from the lungs enters the heart from four veins called the pulmonary veins. Unlike artery, the linings of most veins are fitted with small valves to keep the blood from flowing back to downhill (Fig.7). By the time blood reaches the veins in legs, the force of the heartbeat will be weak and may not be sufficient enough to pump back the blood back to heart. Also the veins in legs have most of the uphill part of the flow circuit, moving against the pull of gravity. But still the blood has to reach heart for next cardiac cycle struggling gravity. The heart needs extra pumping help from the muscles in the feet and calves, which surround the deep veins. The rhythmical contraction and relaxation of these muscles, squeezes and releases the veins, which helps to move blood upwards in the leg as shown in Fig. 8. Also, this process is backed by one-way valves within the veins. These valves open to allow blood to flow up the vein and then close to prevent any backflow. Venous valves help to keep blood flowing in the right direction, from the surface or superficial veins to the deep veins and eventually back to the heart [15].

The influence of gravity cannot be neglected in the studying the detailed blood flow analysis because of constant change of postures, the humans take in day to day life, the blood pressures within the blood vessels will not be same. The pressure within the blood vessels has three basic components, the mean systemic filling pressure, which is related to the volume in the vessel and the wall properties, the dynamic pressure, related to the velocity of the blood flow and the resistance; and the hydrostatic pressure, which is related to gravity and referred as ρgh, where ρ is fluid density, g is the acceleration due gravity and h is the height of the hydrostatic column. The height of the column of blood is always referred at the level of the heart. Within the vascular system the total pressure in a given blood vessel is equal to both the dynamic pressure supplied by the left ventricle of the heart and the hydrostatic pressure [15].

Good blood flow (Net work of blood vessels): With about 60,000 miles of blood vessels and heart as pumping device, they make up the circulatory system which carries blood to every corner of the body. Due to poor circulation the cells in the body can't get all the oxygen and nutrients they need. When the limbs can't get enough blood, hands or feet may feel cold or numb. If you're light-skinned, your legs might get a blue tinge. Poor circulation also can dry the skin, turn nails brittle, and make hair fall out, especially on the feet and legs. Some men may have trouble getting or keeping an erection.

Snuff out tobacco: Nicotine is the active ingredient in cigarettes, electronic cigarettes, and smokeless tobacco. It harms the walls of the arteries and thickens the blood so much, it can't get through. If you smoke, quit. It can be hard to stick with it.

Control Your Blood Pressure: If it's too high, it can cause arteriosclerosis, a condition that hardens your arteries and can help choke off blood flow. Aim for 120 mmHg over 80 mmHg or less, Check your reading at least once a month especially after you reach 50 years. Blood is about half water; stay hydrated to keep it moving. Aim for 8 glasses of water a day. You'll need to drink more if you exercise or if it's hot outside.

Sitting for hours at a time: It isn't great for your circulation or your back. It weakens leg muscles and slows the blood flow in your legs, which could cause a clot. If you're a desk jockey at work, consider a standing desk instead. It may take a little while to get used to, but getting on your feet works the valves in your leg veins, sending blood up to your heart. Yoga is a low-impact exercise that can jump-start your blood flow. When you move, it brings oxygen to your cells. When you twist, it sends blood to your organs.

And upside-down positions shift blood from the bottom half of your body up to your heart and brain.

Yoga and exercise: When your ankles or feet swell, try the legs-up-the-wall yoga pose. Also called viparita karani, it's an easy way to send your blood in the other direction. Lie on the floor or on a yoga mat, with your left or right shoulder close to the wall. Turn your body so you can put your feet up, and smooch your bottom against the wall. Stretch your arms out on the floor with palms down for balance.

Aerobic means "with oxygen. So when you run, bike, walk, swim, and do similar exercises, you take in more oxygen and move it to your muscles. This gets your blood pumping, makes your heart stronger, and lowers your blood pressure. Set a goal to exercise for 30 minutes, 5 to 7 days a week. Break it up into small chunks if needed. If you walk, know that mode-rate to intense speeds - at least 3 miles an hour - offer the best health benefits. This form of strength training not only gets your blood pumping, it also helps lower your blood sugar and helps with back pain. Start with your feet shoulder-width apart and your arms at your sides. Now slowly bend at your hips and knees, but keep your back straight, like you're sitting in a chair. As you return to the starting position, bend your arms for balance.

Eat more plants and less meat: There's no down-side to a balanced diet. Eat lots of fruits and vegeta-bles. Stay away from saturated fats that can be found in red meat, chicken, cheese, and other animal sources. Steer clear of too much salt. That will help keep your weight in a healthy range and your cholesterol and blood pressure in check and your arteries clear.

Massage the body: Sweep your blood in the right direction. Take a body brush with stiff, flat bristles and stroke on your dry skin. Start with your feet and work your way up, using long motions on your legs and arms. Make circles on your belly and lower back. Dry brushing also gets rid of dry skin. Do it every day, right before your shower.

Sip or soak: It's a temporary fix, but a bath is a great way to kick-start your circulation. Warm water makes your arteries and veins open a bit wider, letting more blood through. Hot water or tea does the trick as well.

Net work of blood vessels: There are five main types of blood vessels viz., arteries, arterioles, capillaries, venules and veins. Arteries carry blood away from the heart to other organs. They can vary in size. The largest arteries have special elastic fibres in their walls. All three of these vessels transport blood, oxygen, nutrients, and hormones to organs and cells [16].

The arteries are the thickest of all blood vessels and have muscular walls that contract to keep the blood moving away from the heart. The veins are not as muscular, but they contain valves to prevent the blood from flowing backward. The arteries are therefore widest blood vessels.

Arterioles carry blood and oxygen into the smallest blood vessels, the capillaries. Capillaries are so small they can only be seen under a microscope. The walls of the capillaries are permeable to oxygen and carbon dioxide. Oxygen moves from the capillary toward the cells of the tissues and organs. Smaller arteries and arterioles are called 'resistance vessels' because they play a crucial role in the regulation of blood pressure.

Vascular capacitance refers to degree of active constriction of vessels (mainly veins) which affects return of blood to the heart and thus cardiac output. Capacitance vessels are considered to be the blood vessels that contain most of the blood and that can readily accommodate changes in the blood volume. Veins are also called capacitance vessels because they contain 60% of the body's blood volume. In systemic circulation, oxygenated blood is pumped by the left ventricle through the arteries to the muscles and organs of the body, where its nutri-ents and gases are exchanged at capillaries. Blood pressure is highest as its leaves the heart through the aorta and gradually decreases as it enters smaller and smaller blood vessels (arteries, arterioles, and capillaries)

Blood-tissue barriers: Blood tissue barrier prevents solutes in the circulating blood from non-selectively crossing into the extracellular fluid. Nature has provided this type of arrangement only for certain tissue/organs in the body [17]. For example blood–air barrier (alveolar–capillary barrier or membrane) exists in the gas exchanging region of the lungs. It exists to prevent air bubbles from forming in the blood, and from blood entering the alveoli.

Blood–ocular barrier: It is a barrier created by endothelium of capillaries of the retina and iris, ciliary epithelium and retinal pigment epithelium. It is a physical barrier between the local blood vessels and most parts of the eye itself, and stops many substances including drugs from travelling across it. It consists of the aqueous barrier and retinal barrier.

Blood–aqueous barrier: It is in ciliary epithelium and capillaries of the iris. It is formed by non pigmented ciliary epithelial cells of the ciliary body and endothelial cells of blood vessels in the iris.

Blood–retinal barrier: Non-fenestrated capillaries of the retinal circulation and tight-junctions between retinal epithelial cells preventing passage of large molecules from chorio-capillaris into the retina.

Blood–thymus barrier: regulates exchange of substances between the circulatory system and thymus, providing a sequestered environment for immature T cells to develop. The barrier also prevents the immature T cells from contacting foreign antigens (since contact with antigens at this stage will cause the T cells to die by apoptosis). The barrier is formed by the continuous blood capillaries in the thymic cortex by thymic epithelial cells and macrophages.

The blood–brain barrier (BBB): It is an essential requisite for maintenance of homeostasis and physiological environment of the central nervous system (CNS). It is a distinctive interface between CNS and peripheral circulation that strictly regulates the entry of specific molecules from circulation or their clearance by highly selective semipermeable border of endothelial cells.

Since the blood-brain barrier is not fully developed at birth, the risk of toxicity from exposure to some chemicals is higher for newborns and young children than it is for adults. It also has an important function in protecting the brain from the entry of harmful substances. Large molecules do not pass through the BBB easily. Low lipid (fat) soluble molecules do not penetrate into the brain. However, lipid soluble molecules, such as barbituate drugs, rapidly cross through into the brain. Molecules that have a high electrical charge are slowed.

Circulating caffeine can readily cross the blood-brain barrier. Due to its structural similarity with adenosine, caffeine in the brain can act as an antagonist such that it binds adenosine receptors but do not activate them. The existence of the BBB represents the key challenge for the delivery of therapeutic agents to the brain. However, the development of nanotechnology-based approaches for brain delivery, such as nanoparticles, liposomes, dendrimers, micelles, and carbon nanotubes, might be the solution for improved brain therapies

Blood-testis barrier (BTB): It is a physical barrier between the blood or lymph vessels and the lumen of seminiferous tubules of the testes and exists in all animals. It is a structural and physiologic compartment created by inter–Sertoli cell tight junctions located on the luminal side of the basally positioned spermatogonia and the earliest germ cells that develop from them. The blood-testis barrier is first formed in the peripubertal period during the initiation of spermatogenesis in response to gonadotropic stimulation. Thus testosterone and a cytokine act together to differentially regulate and coordinate the dynamics of the tight junctions, maintaining the integrity of the blood testis barrier, yet allowing germ cells to cross the barrier and continue with meiotic maturation

VII. Blood Disorders

Any health condition in which something is wrong with part of the blood is a blood disorder. Blood disorders affect whole body. Sometimes there are too many of certain blood cells. Other times, the blood has too little or too much of something it needs to work normally, such as a clotting factor. The symptoms will depend on which blood disorder it is and which part of the blood isn't working normally. Many other things can cause those symptoms [19]. There are several different types of causes. Many blood disorders are genetic and passed down from one generation to the next. Some happen as a result of other diseases. Some happen as a side effect of certain medicines or when people don't get enough of certain nutrients in their diets. Sometimes doctors don't know the cause [20-24]. In many blood disorders, problems arise because there aren't enough of certain blood cells. When there aren't enough red blood cells, doctors call this anemia. When there aren't enough white blood cells, doctors call this leukopenia. When there aren't enough platelets, doctors call this thrombo-cytopenia.

Anemia: There are many types of anemia. Iron

deficiency anemia is a common one that happens when people don't have enough iron. Your body needs iron to make healthy red blood cells. This type of anemia may happen if you don't get enough iron in the food you eat or your body doesn't take iron in well. Sometimes other health conditions lead to this type of anemia. Treatments may include iron supplements, eating iron-rich foods, iron infusions, or blood transfusions.

Sickle cell disease: Sickle cell disease, or sickle cell anemia, is an inherited blood disorder. It happens when an abnormal protein in red blood cells makes them hard, sticky, and shaped like a letter "C." These abnormal red cells die, causing anemia. They also can get stuck in small blood vessels to cause pain, stroke, or other problems.

Thalassemias: Thalassemias are also inherited. They happen when a faulty gene causes the body to make too few red blood cells and hemoglobin. Hemoglobin is the iron-rich protein in red cells that carries oxygen. Some thalassemias are more severe than others. Some people with thalassemia don't need treatment. Other people may need blood transfusions, treatment to remove extra iron, and supplements with a vitamin called folic acid.

Von Willebrand disease: A missing or faulty protein causes this inherited disease. The body needs this protein for blood to clot normally. So, people with this condition often have excessive bleeding and bruising. Doctors treat it with medicines that replace the missing protein or make cells release more of it.

Hemophilia: Hemophilia is another inherited bleeding disorder. It happens in people who lack one of two other important clotting factor proteins. Doctors treat it with infusions to replace the missing factor.

Venous thromboembolism: This disorder happens when a blood clot forms in deep veins. If the clot is in the leg or pelvis, doctors call it deep vein thrombosis (DVT). If a clot breaks free and travels to the lungs, doctors call it pulmonary embolism. It happens most often after surgery, injury, or in people with other health conditions. Treatments include medications to prevent clotting or procedures to remove or catch clots.

Blood cancers: Some blood disorders are cancers. Some people have no symptoms if at all come on slowly; sometimes it is not noticed till it might fully manifest. But there are a few things to look for with the most common kinds of blood cancer [21,22]. Common blood cancers include chronic lymphocytic leukemia. Blood cells are made inside bone marrow, and that's where leukemia starts. It causes body to make white blood cells that grow out of control and live longer than they're supposed to. And unlike normal white blood cells, they don't help your body to fight infection.

There are many different forms of leukemia. Some get worse quickly (acute). You'll probably feel very sick very suddenly, like you've come down with the flu. Other forms can take years to cause symptoms (chronic). Your first clue may be abnormal results on a routine blood test. Most signs of leukemia happen because the cancer cells keep the healthy blood cells from growing and working normally.

Anemia: This is when the body doesn't make enough red blood cells, or the ones you have don't do their jobs well.

Poor clotting: Platelets are the cells that make your blood clot. When your body doesn't make enough of them, small cuts may bleed more than usual, or you might have a bloody nose often.

Other symptoms: Because your white blood cells don't fight infection well, you'll get sick more often and take longer to get over it. You may get a lot of fevers and have night sweats. Cancer cells can build up in the lymph nodes, tonsils, liver, and spleen and cause them to swell. Lumps are felt around neck or armpits; weight loss and bone pain can also be felt.

Non-Hodgkin's lymphoma: Lymphocytes grow out of control and make it harder to fight infection. Swollen lymph nodes are the main sign of lymphoma. Lumps are developed around neck, armpit, or groin. Enlarged spleen may also take place. Some other common signs of lymphoma are fever, night sweats, feeling tired, unexplained weight loss and Itchy skin

Multiple myeloma: The plasma cell is another type of disease-fighting cell in your bloodstream. Multiple myeloma causes your bone marrow to make plasma cells that grow out of control and keep your body from making enough healthy blood cells. They also release chemicals into your blood that can hurt your organs and tissues. Some forms get worse faster than others, but symptoms typically don't show up.

The most common sign of multiple myeloma is serious and long-lasting pain, usually in your back or ribs. The cancer cells release a chemical that stops the normal growth and healing process in bones. They get thin and weak and can break easily, loss of bowel or bladder control.

Multiple myeloma causes high levels of calcium in the blood. Too much calcium in your blood can also hurt your kidneys. Signs include swollen ankles, shortness of breath, and itchy skin. Certain proteins made by the cancer cells can damage nerves, which can cause weakness, numbness, and pain in the arms and legs. Multiple myeloma cells also crowd out healthy cells in the blood [23,24].

Cord blood banking: Until early 1990s the umbilical cord and its blood were considered medical waste. Now, cord blood banking is well developed and the cord blood is utilized as a regenerative medicine for the treatment of life-threatening and debilitating diseases. Cord blood refers to a sample of blood collected from the umbilical cord when a baby is born. The umbilical cord is the cord connecting the baby to the mother's womb. Cord blood testing can be done to evaluate a newborn's health. Cord blood contains blood (haematopoietic) stem cells, which can produce all the other cells found in blood, including cells of the immune system. It can be easily collected and frozen for later use. Cord blood contains blood-forming stem cells that can be used in the treatment of patients with blood cancers such as leukemias and lymphomas, as well as certain disorders of the blood and immune systems, such as sickle cell disease and Wiskott-Aldrich syndrome. However, cord blood is not a cure for all blood disorders (Fig. 9).

Cord blood and menstrual blood are currently approved by the FDA for the treatment for nearly 80 diseases, and cord blood treatments have been performed more than 35,000 times around the globe to treat cancers (including lymphoma and leukemia), anemias, inherited metabolic disorders and some solid tumours and orthopedic repair. The most exciting of these are autism, cerebral palsy and Alzheimer's.

Processing and cryo-preservation:. The sample of the cord blood is tested for microbiological contamination, and the mother's blood is tested for infectious diseases. As these tests are being conducted, the cord blood is processed to reduce the number of red blood cells since the Red blood cells can have a negative impact on a cord blood transfusion and its total volume and isolate the stem cells and immune cells. Once the stem and immune system cells have been isolated and extracted from the plasma and red blood cell, they are mixed with a cryo-protectant and stored in a cryo-bag.The over-wrapped cryo-bag is housed in a protective metal cassette and placed in vapor-phase liquid nitrogen freezer for long term preservation.

Conversion of human umbilical cord blood and menstrual blood into neural stem cells: The advances in direct lineage conversion technology have facilitated the obtaining of diverse somatic cell types for regenerative medicine. Bypassing the pluripotent state, this technology could resolve the limitations of directed differentiation strategies using induced pluripotent stem cells (iPSCs). Several studies have reported that direct conversions into terminally committed cells such as neurons, hepatocytes and cardiomyocytes could complement the long-term differentiation and teratoma formation issues of iPSCs. However, these cell types inherently limit therapeutic applications because they are unable to proliferate [27]. Thus, transdifferentiation into specific adult stem or progenitor cells has proven to be advantageous for scalability and biomedical applications. Using this strategy, hepatic stem cells, hematopoietic progenitor cells, oligodendrocyte progenitor cells and neural stem cells have been successfully induced from mouse and human somatic cells.

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